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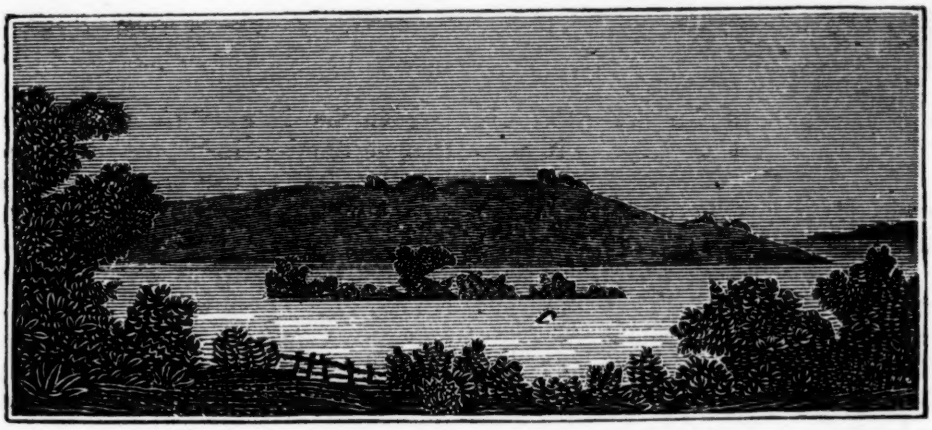
"A taste for knowledge, a capacity to acquire it, and a pleasure accompanying its acquisition, form the constitution of every mind."—DR. DICK.



## *History of Astronomy—its various Systems, &c.* [Continued from page 101.]

OF THE STRATUS.—This modification has a mean degree of density.

It is the lowest of clouds, since its inferior surface commonly rests on the earth or water, as represented by the figure above annexed.

Contrary to the last, which may be considered as belonging to the day, this is properly the cloud of night, the time of its first appearance being about sun-set. It comprehends all those creeping mists which in calm evenings ascend in spreading sheets (like an inundation of water) from the bottom of valleys, and the surfaces of lakes, rivers, &c. &c. Its duration is frequently through the night.

On the return of the sun, the level surface of this cloud begins to put on the appearance of cumulus, the whole at the same time separating from the ground. The continuity is next destroyed, and the cloud ascends and evaporates, or passes off with the appearance of the nascent cumulus.

This has been long experienced as a prognostic of fair weather, and indeed there is none more serene than that which is ushered in by it. The relation of the stratus to the state of the atmosphere, as indicated by the barometer, &c. appears notwithstanding to have passed hitherto without much attention.

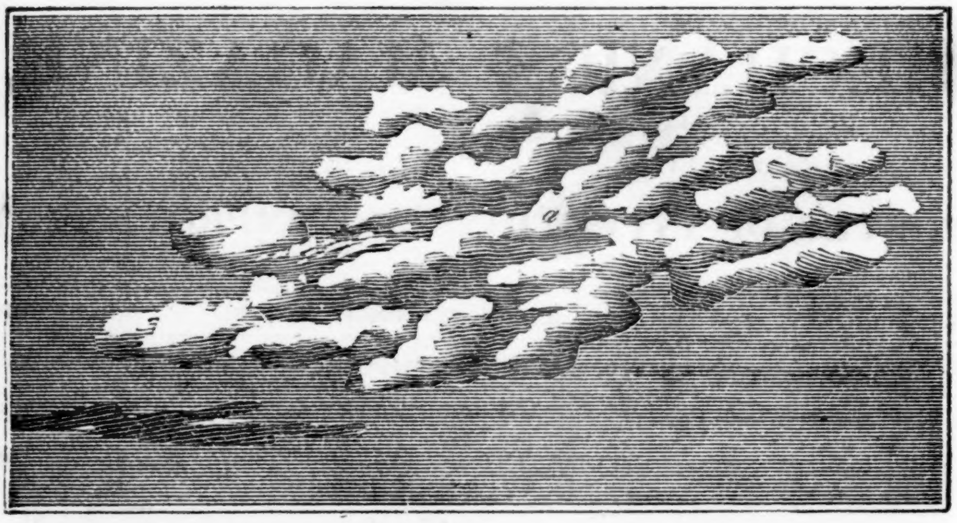
OF THE CIRRO-CUMULUS.—The cirrus having continued for some time increasing or stationary, usually passes either to the cirro-cumulus or the cirro-stratus, at the same time descending to a lower station in the atmosphere.

The cirro-cumulus is formed from a cirrus, or from a number of small separate cirri, by the fibres collapsing as it were, and passing into small roundish masses, in which the texture of the cirrus is no longer discernible, although they still retain somewhat of the same relative arrangement, as exhibited by the following figure. (See next page.)

This change takes place either throughout the whole mass at once, or progressively from one extremity to the other. In either case the same effect is produced on a number of adjacent cirri at the same time, and in the same order. It appears in some instances to be accelerated by the approach of other clouds.

This modification forms a very beautiful sky, sometimes exhibiting numerous distinct beds of these small connected clouds, floating at different altitudes.

The cirro-cumulus is frequent in summer, and is attendant on warm and dry weather.

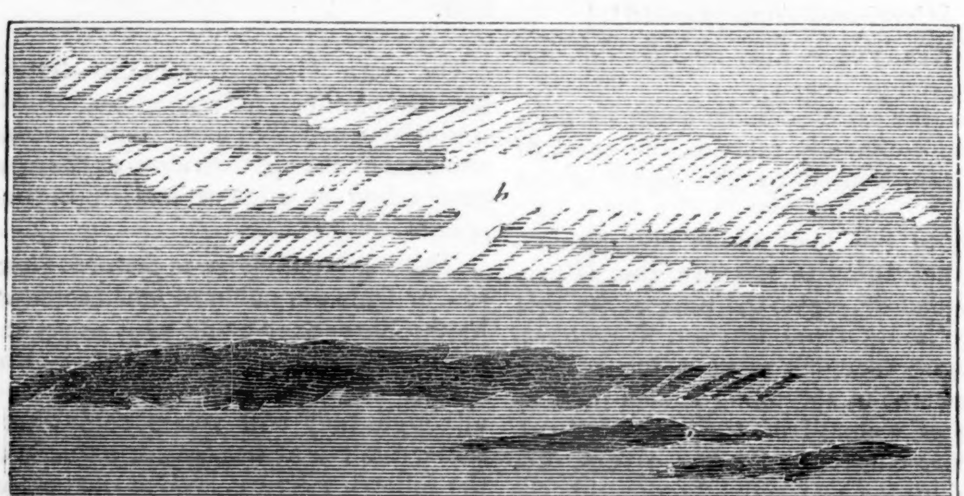



It is also occasionally and more sparingly seen in the intervals of showers, and in winter.

It may either evaporate or pass to the cirrus or cirro-stratus.

Of the Cirro-Stratus.—This cloud appears to result from the subsidence of the fibres of the cirrus to a horizontal position, at the same time that they approach towards each other laterally. The form and relative position, when seen in the distance, frequently give the idea of shoals of fish. Yet in this, as in other instances, the structure must be attended to rather than the form, which varies much, presenting at other times the appearance of parallel bars, interwoven streaks, like the grain of polished wood, &c. It is always thickest in the middle, or at one extremity, and extenuated towards the edge, as represented by the following figure.

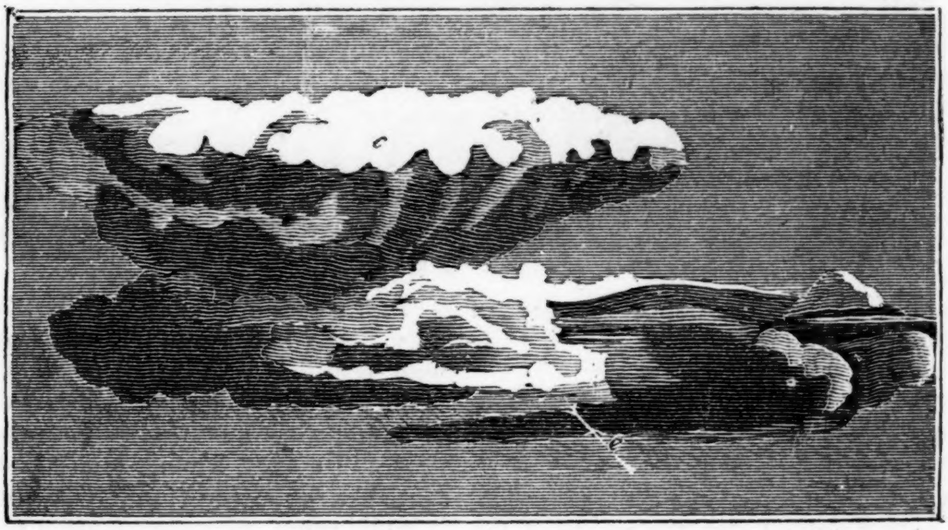
The distinct appearance of a cirrus does not always precede the production of this and the last modification.




The cirro-stratus precedes wind and rain, the near or distant approach of which may sometimes be estimated from its greater or less abundance and permanence. It is almost always to be seen in the intervals of storms. Sometimes this and the cirro-cumulus appear together in the sky, and even alternate with each other in the same cloud, when the different evolutions which ensue are a curious spectacle, and a judgment may be formed of the weather likely to ensue, by observing which modification prevails at last. The cirro-stratus is the modification which most frequently and completely exhibits the phenomena of the solar and lunar halo, and (as supposed from a few observations) the parhelion and paraselene also. Hence the reason of the prognostic for foul weather, commonly drawn from the appearance of the halo.

Of the Cumulo-Stratus.—The different modifications which have been just treated of sometimes give place to each other,

at other times two or more appear in the same sky ; but, in this case, the clouds in the same modification lie mostly in the same plane of elevation ; those which are more elevated appearing through the intervals of the lower, or the latter showing dark against the lighter ones above them. When the cumulus increases rapidly, a cirro-stratus is frequently seen to form around its summit, reposing thereon as on a mountain, while the former cloud continues discernible in some degree through it. This state continues but a short time. The cirro-stratus speedily becomes denser, and spreads, while the superior part of the cumulus extends itself and passes into it, the base continuing as before, and the convex protuberances changing their position, till they present themselves laterally and downward. These are well represented by the following figure.



More rarely the cumulus alone performs this evolution, and its superior part constitutes the incumbent cirro-stratus.

In either case a large lofty dense cloud is formed, which may be compared to a mushroom, with a very thick short stem. But when a whole sky is crowded with this modification, the appearances are more indistinct. The cumulus rises through the interstices of the superior clouds, and the whole, seen as it passes off in the distant horizon, presents to the fancy mountains covered with snow, intersected with darker ridges, and lakes of water, rocks, and towers, &c.

The distinct cumulo-stratus is formed in the interval between the first appearance of the fleecy cumulus and the commencement of the rain, while the lower atmosphere is yet too dry ; also, during the approach of thunder storms ; the indistinct appearance of it is chiefly in the longer or shorter intervals of showers of rain, snow, or hail.

The cumulo-stratus chiefly affects a mean state of the atmosphere as to pressure and temperature, but in this respect, like the other modifications, it affords much room for future observation.

Of the Nimbus, or Cumulo-Cirro-Stratus.—Clouds, in any of the preceding modifications, at the same degree of elevation, or in two or more of them, at different elevations, may increase so as completely to obscure the sky, and at times put on an appearance of density, which, to the inexperienced observer, indicates the speedy commencement of rain. It is nevertheless extremely probable, as well from attentive observation as from a consideration of the several modes of their production, that the clouds, while in any one of these states, do not at any time let fall rain.

Before this effect takes place, they have been uniformly found to undergo a change, attended with appearances sufficiently remarkable to constitute a distinct modification, which is represented by the following figure, called the Nimbus, or Cumulo-cirro-stratus cloud. (See next page.)

In this figure a shower is represented as coming from behind an elevated point of land.

The nimbus, although in itself one of the least beautiful clouds, is yet now and then superbly decorated with its attendant, the rainbow, which can only be seen in perfection when backed by the widely extended uniform gloom of this modification.

The relations of rain, and of periodical showers more especially, with the varying temperature, density, and electricity of the atmosphere, will probably now obtain a fuller

investigation, and with a better prospect of success than heretofore.

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*Remarks on the Rival Claims to the Introduction of Steam Navigation.* [From the London Mechanics' Magazine.]

SIR,—It must be evident to every one, that not only England, but the whole of the civilized world, is under immense obligations to the individual who first rendered steam available to the purposes of navigation. Public opinion, however, seems still to vibrate between the conflicting claims to this honor put forward by the late William Symington, Mr. Miller, of Dalswinton, (or rather by his representatives on his behalf,) and Mr. Jas. Taylor. As to those of Fulton* and Bell, they seem, according to common consent, to be wholly untenable.

We will, if you please, begin "wi' the laird" first. Mr. Miller was a man of property, possessed of an active mind, which was constantly requiring excitement. He was, therefore, always ready to enter into any experiments which promised to afford him that mental stimulus congenial to his feelings. He was, consequently, very ready to assist with his patronage young men who possessed inventive genius, or supposed that they were so blessed, and, of course, was very commonly disappointed. As he was easily induced to begin experimentalizing, he was just as apt to quit it without carrying it on to a successful result. For, although not deficient in wealth, he lacked that spirit of perseverance from which alone success can emanate.

* We shall shortly have something more to say on this subject. Fulton most certainly had some claims: to what extent we shall examine shortly.—[ED. AM. M. M.]

Taylor was a tutor in this Mr. Miller's family. He had been on terms of intimacy with William Symington, when at the University of Edinburgh, and had seen a model of an improvement which Symington (though then still a very young man) had just perfected in the steam engine. In consequence, it would seem, of some mention made to Mr. Miller of Symington, (very probably by Taylor,) Mr. Miller, early in 1786, called upon Symington, who was then in the employment of, and residing with, Mr. Gilbert Meason, the manager of the Wanlock-Head Mining Company, and after conversing with him for some time, engaged him to make some experiments, for the purpose of ascertaining the practicability of propelling boats by steam. Miller himself had, previously to this, attempted to move boats by means of wheels, set in action by treddles, a plan which he was compelled to abandon from the excessive fatigue it occasioned to the men employed. This scheme, by the way, had not even the charm of novelty to recommend it, for it had been practised by the Romans, who used oxen to work machinery; and also by Savary, who had, like Mr. Miller, exerted human force for that purpose.*

The biographer of Taylor, in "Chambers' Journal," states that he "attended the University of Edinburgh for several years;" that the classes selected by him were anatomy, surgery, and chemistry; and that he "prose-

* Mr. Miller seems to have had a predilection for appropriating other persons' inventions to himself; or, if *he* had not, his friends have endeavored to do so for him, as they would willingly have us to believe that the piece of sea ordnance, known as the carronade, was the fruit of Mr. Miller's genius, when, in fact, it was invented by Mr. Gascoigne, one of the proprietors and managers of the Carron Iron Works, from which circumstance it derived its name.

cuted his studies with much assiduity and success, for at the end of his course he was prepared to enter *either* upon the profession of medicine or divinity"!! Now, if the College Album be an authority to be confided in, Taylor matriculated for *one* season only, and attended the classes above mentioned for one course each. "One swallow," says the adage, "does not make a summer;" but according to Taylor's biographer, one course of lectures fully qualified him to be either a physician or a divine? I make no doubt that he was just as well qualified for the one as the other—that is, not at all. I agree with the writer in "Chambers' Journal," that his genius was excursive, and that to a very considerable extent; but I have yet to learn, that its excursions were ever attended by any beneficial result. He is said to have had a predilection for mineralogy, geology, and mechanics; but if this were true, how comes it that Taylor, being at the University where those subjects were treated upon scientifically, never availed himself of so excellent an opportunity of attending the classes in which they were taught?

The improvement of the steam engine, devised by Mr. Symington, was accomplished in 1785–1786, and it was in the spring of 1786 that Mr. Miller, as already mentioned, engaged him to carry on some experiments upon steam navigation. These were made upon the lake at Dalswinton, Mr. Miller's property, in 1788. It is asserted that Mr Taylor remained in Edinburgh after Mr. Miller had left, to superintend castings of the parts of the engine intended to be employed in moving the boat. But if this were necessary, why did not Taylor afterwards put the engine together? If he were capable of furnishing the drawings and models by which the various parts were to be constructed, surely there could be no necessity for sending for Mr. Symington from the Lead hills, to put the different pieces properly "*in situ.*" Mr. Miller would have been little less than mad to employ Symington in these experiments, when he had such a brilliant and inventive genius as Taylor residing under his own roof. If (as has been asserted) Taylor was the author of these experiments, where are the drawings and documents to substantiate his claim? Have they ever been seen by any person? Or, indeed, have they ever existed, except in the imagination of his partisans?

There is an account of these experiments to be found in the "Scots Magazine" for 1788, which it has been allowed was drawn up by Taylor himself. He acknowledges, in this statement, that the merit of the expense of trying the experiment was due to Mr. Miller, but that the engine used upon the occasion was the sole invention of Mr. Symington, and throughout the whole account he never introduces his own name, either directly or by implication. The notice alluded to is subjoined.*

In 1789, Taylor is represented as being located at the Carron Iron Works, for the purpose of superintending the castings of an engine of increased size, the cylinders being 18 inches in diameter. But in opposition to this, we have the affidavit of Mr. Stainton, one of the managers of these works, who states that—

"He (Taylor) was never considered capable of superintending the work; that he never furnished a single drawing or model by which the work might be forwarded; but that, on the contrary, Mr. Symington was looked up to as being the person to whom all the necessary inquiries for the completion of the engine were to be addressed; and that, so far from considering Taylor as a principal, he was rather looked upon as a spy, appointed by Miller to watch Symington's conduct, that he did not waste too much of his time upon some experiments he was conducting at the same moment for the Wanlock-Head Company."

The experiments with the new engine succeeded entirely; but when it had arrived at that point, that by a little more exertion it might have been perfected, Mr. Miller's excitement was over. He had been bitten by an agricultural mania, dismantled the steamboat, and left steam navigation to be promoted by other hands.

In 1801 and 1802 Mr. Symington renewed his experiments under the patronage of Lord Dundas, that nobleman having purposely gone down from London to engage him. He continued them until 1803, when he completed a steam tug, which towed two merchant vessels 19½ miles upon the Forth and Clyde canal, against the wind, in the presence of many spectators. Mr. Symington

* "On October 14 a boat was put in motion by a steam engine, upon Mr. Miller of Dalswinton's piece of water at that place. That gentleman's improvements in naval affairs are well known to the public. For some time past his attention has been turned to the application of the steam engine to the purposes of navigation. He has now accomplished, and evidently shown to the world, the practicability of this by executing it upon a small scale. A vessel 25 feet long and 7 broad was on the above date driven with two wheels by a small engine. It answered Mr. Miller's expectations fully, and afforded great pleasure to the spectators. The success of this experiment is no small accession to the public. Its utility in canals, and all inland navigation, points it out to be of the greatest advantage, not only to this island, but to many other nations of the world. *The engine used is Mr. Symington's new patent engine.*"—[Scots Magazine, Nov. 1788, p. 566.]

took out a patent in the usual way for the protection of his invention in 1801; and this fact must dispose of the charge of his having practised any concealment or secrecy with regard to the matter.

A letter has been published, from Mr. Symington to Taylor, in which the former promises to make over half the profits of the invention to the latter. This originated, I am told, in a representation made by Taylor, that he was possessed of considerable influence amongst noblemen and members of parliament, through whose intercession a parliamentary grant might be obtained. But even supposing Mr. Symington was not entitled to the honor of being the first applier of steam to the purposes of navigation, Taylor, from his own showing, and from that of his friend, must have still less claim; for he states, that he (Taylor) called upon Mr. Miller, and endeavored to persuade *him* to secure the right to the invention by a patent. If it was Miller's invention, Taylor's regretting his own incapability of securing the right by patent is an absurdity.

Taylor's real friends cannot be much obliged to Mr. Chambers for his biography, for it certainly exhibits him in any thing but an amiable point of view. We find him, in the first place, acting as a spy upon his intimate friend Symington, and afterwards engaging in a secret correspondence with his patron Mr. Miller's most intimate friends, for the purpose of robbing him of the fruits of his experiments, by taking them away to a foreign country; and this he did after having vainly endeavored to make Miller as dishonest as *he* wished to be, in taking out a patent to secure to himself the profits of another man's genius.

If Mr. Symington had not expended his private fortune previously to 1815, and which he did in experimentalizing, there would not have been any occasion for this letter, as there would have then been ample legal proof on record of the originality of his invention. I am, sir, yours obediently,

CH.

London, May 28, 1834.

[We have great pleasure in inserting the preceding communication, because, though it contains little that is new on the subject of Mr. Symington's claims, and puts some points less forcibly than has been already done in our pages, (see particularly vol. xix. p. 121,) it is the spontaneous production of a physician who holds a high place in public opinion, and serves to show these claims are gaining ground among those enlightened and reflecting classes of the community with whom the decision of all such matters must ultimately rest. We feel persuaded that the time is now but little distant, when we shall have to congratulate the family of Mr. Symington on the complete and triumphant recognition of his title to be regarded as the first person who practically demonstrated the immense benefits to be derived from the application of steam power to navigation. —ED. LOND. M. M.]

*A Compendium of Civil Architecture, arranged in Questions and Answers, with Notes, embracing History, the Classics, and the Early Arts, &c.* By ROBERT BRINDLEY, Architect, Surveyor, and Engineer. [Continued from page 72.]

MISCELLANIES.

Q. How are *Artificer's works* appreciated in the Metropolis?

A. At *fair measure and value prices*, agreeably to a given standard.

Q. What are the walls of houses principally built of in town?

A. Bricks—known of different qualities, as *common place, grey stocks, pickings, seconds, marles, cutters, paviors, &c.**

Q. How are bricks worked?

A. In headers or stretchers, laid either in *Flemish bond* or *English bond.*

Q. What is Flemish bond?

A. Bricks laid alternately in a course—first a stretcher, then a header—which is the general custom.

Q. What is English bond?

A. When one course of bricks is stretchers, and the other course headers, and so on alternately.

Q. How is brickwork measured and valued?

A. By the *rod.*

Q. What are the foundations of brickwork called?

A. Footings.

Q. What are *reveals?*

A. External recesses of four inches thick, formed by the recess of the window frames. Sometimes there are double reveals introduced, which become ornamental.

Q. What are *gauge arches?*

* The making of bricks deserves record—Kent and Essex claim precedency over all other counties in the art. In the first instance, clay and chalk are collected in large quantities, and brought to the *pug mill* (a large vat) placed in a circular excavation, in which an iron spindle with horizontal blades is fixed, and from which spindle a shaft projects, having a horse harnessed, and travelling round grinds the soil, which, emptying itself into the excavation, at the same time water is pumped therein, forms a liquid, and passing through a grating falls into a large *back* prepared for the purpose. Here the mixture is allowed to remain until it becomes a solid body. A certain portion of ashes is then strewed over the surface, and mixed with the same, which is again brought to the pug mill, ground, and taken to the hands of the brickmaker, who moulds it; from him it is conveyed to the *hacks* (prepared level surface of earth,) where the bricks are all disposed in long ranges, and in two lengths transversely, a little open to admit air, and carried to the height of four feet, where they remain from ten to twenty days, till hardened by the atmosphere and sun. They are then regularly disposed on a large area of level ground, with *breeze* (fine cinders) laid on the surfaces of every seventh or eighth tier, and then set on fire; hence, a pile, called a *clamp*, containing from half a million to two millions of bricks, is formed, and the bricks gradually burnt and produced in such qualities as the soil and the fire have combined to effect. The best bricks, as marles, paviors, &c. have the greatest quantity of chalk. Pantiles, plaintiles, &c. are made in a similar manner.

A. They are either straight, circular, or elliptical, forming a *fascia*, and are bricks rubbed, and neatly set in putty or mortar—radiating from a given centre, and presenting their several thicknesses as stretchers and headers, or closers.

Q. What are *splays*?

A. The interior or exterior obtused angles of the sides of doors, windows, &c.

Q. What are *quoins*?

A. The external angles of the buildings.

Q. What are *ramps*?

A. Segmental or elliptical sweeps in a wall that is erected on an inclined plane, to give it nearly an equal height all along.

Q. What is *coping*?

A. The summit of the wall; the bricks being laid edgeways, presenting themselves as headers.

Q. What are *strings*?

A. Longitudinal projections of different depths, in fronts, &c. of buildings.*

Q. What are *party walls*?

A. The division walls of rows of houses.

Q. What are *chimney breasts*?

A. Brickwork projecting from the walls to form the hearth; the piers on each side are termed the *jaumbs*, through which, in upper stories, the *flues* of the chimney pass to the *shaft*, which forms the chimney.† In the internal part, the chimney breast *splays*, which is called the *wings* to the entrance of the flues, which are one and a half brick by two bricks square.‡

Q. What is *nogging work*?

A. Brickwork laid between the partition framing, and is worked in brick of four inches thick, agreeably to the partition frame.

Q. What is *pointing* of brickwork?

A. The filling up of the joints of brickwork, denominated *flat joint* in the common manner, or *tuck jointed*, done with cement, in a superior manner, over grey mortar.

Q. What is meant by *scaffolding*?

A. The erection of spars, called *scaffold poles*, around the buildings, which are severally lengthened by others being lashed to them by ropes, as the work is carried up; and *putlocks*, the cross pieces, one end tied to the poles, and the other resting on the brick or stone work, for the purpose of laying the deals on. In large and high buildings, particularly steeples, columns, &c. great ingenuity is requisite to maintain sufficient strength in the unison of these parts. *Guys* or ropes are frequently had recourse to, leading from the summit of the scaffolding to some post driven in the ground, at a distance from the building.

Q. What is meant by the *carcase* of a house?

A. Simply the stone or brickwork, with the roofing, joists, and partitions.

Q. How are *sewers* or *drains* constructed?

A. With bricks or stones, in various arches—as semi-circular, elliptical, scheme, square, &c. The lesser drains are circular, and denoted as *gun-barrel drains*. Their constructions are liable to Acts of Parliament.

### PLASTERER.

Q. What is plasterer's work?

A. The plastering of a building internally in its several coats, denominated *rough rendering*, being the first coat of plaster on walls—*floated rendering* the second coat, of fine lime and hair—and *set work*, the third coat, *fine stuff*, part lime and sand. On partitions and ceilings, *lath and plaster and set*, or *floated lath and plaster set*.

Q. How are the best rooms finished internally?

A. The walls are *trowelled stucco*, i. e. plastered with fine lime and sand, and lime water, with the smoothest surface.

Q. How are external walls finished?

A. Sometimes *rough cast*, (a rough plaster thrown thereon, called *slap-dash*,) but frequently *rough stuccoed*, presenting the appearance of stone work, with rustics, &c.

Q. What is *lime*?

A. A viscous substance, and is known as *chalk lime* and *stone lime*. The former partakes of two qualities, as *flame lime*—the chalk being burned in large lumps, in kilns, by furnaces beneath, heated with coals, and is of a much stronger nature than the *tunnel lime*, burnt in a tunnel kiln, in small pieces of chalk, mixed with culm, cinders, breeze, or ashes, in equal proportions. *Stone lime* is burnt with coals, or culm, in kilns, and is of greater strength than either.

Q. What is *mortar*?

A. Lime and sand,* mixed in equal pro-

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NOTE.—Walls are said to *batter* when the external face at the base projects and diminishes upwards to any given height, and then carried up perpendicularly, as batteries, &c. The proportion is one inch in a foot.

* Cornices, pilasters, plinths, strings, sills, &c. are frequently worked in bricks.

† In large buildings all the flues of the several chimneys are brought to the centre shaft, the same being sprung by arches from their respective chimney breasts.

‡ An Act of Parliament was passed in 14 Geo. III. cap. 78, entitled "An abstract of the London Building Act," dividing buildings into seven classes, regulating all party walls, chimneys, &c.

* Lime, a very useful earth, which absorbs moisture and carbonic acid, and exists as lime stone, and in marble and chalk, which when burnt becomes lime. It consists of oxygen and a metallic base called calcium. It fixes the gaseous constituents of water, which in losing their motion transfer it in great heat to surrounding bodies. In its native state it is called carbonate of lime, and burnt to disengage the carbonic acid. When made into a paste of one

portions according to the strength of the former, with water, and is used for laying of stones, bricks, plastering, &c.

Q. What is *Roman cement?* ?

A. A composition of lime and earth, by which all external ornaments, as sills, pilasters, cornices, rustics, &c. are worked.

Q. What are *Terras* and *Pozzolona ?*

A. Terras is a volcanic production, consisting chiefly of clay and oxide of iron, indurated together. Pozzolona is another volcanic production, differing but little from the former. It is thrown out of volcanoes in the form of ashes, and abounds in the kingdom of Naples. The cement used in the construction of the Eddystone lighthouse is composed of equal parts of lime and pozzolona, as best adapted for marine purposes.

Q. What is *Plaster of Paris ?*

A. *Burnt gypsum*, a combination of 42 parts of lime and 58 of sulphuric acid, with which all enrichments for cornices, soffits, frets, flutings, festoons, husks, flowers, &c. are cast, and attached to the ceilings.

CARPENTER.

Q. What is carpenter's work ?

A. The rough timber work, as *girders*, severally introduced into large buildings, to support the joists; *oak joists* and *sleepers*, for the ground floors; *wall plates*, to receive the ends of joists on, which are framed by *trimmers* to fire places, and the *well holes* of staircases. *Lintels*, (generally oak,) thrown over all apertures, to receive any contingent pressure. *Bond timber*, worked longitudinally into walls, to give additional strength, and receive any fastenings. *Quarter partitions*, framed, consisting of *heads, sills, quartering, enterties, braces, puncheons*, &c. stretching across the joist; or *skeleton partitions*, simply, quartering nailed to the joist, without heads, sills, &c. The roofing of the building, with *binders, ceiling joist*, also *brest summers*, for shop fronts, and *story posts* to support the same, all *luffer boarding*, or *weather boarding*, together with *cradling for centres*, &c. Also *fencing* to parks, and *rough work* in general.

part water with three parts lime, it is called hydrate of lime; and being mixed with silica, alumina, and oxide of iron, it forms plastic cements, and mortars; and afterwards imbibing carbonic acid from the atmosphere, it becomes again a carbonate of lime, as hard as at first: and hence it is used in building. *Slake lime* is so called when it has been wet or damaged. The tunnel lime is much used in the eastward for manure, as also the stone lime in the westward. Northfleet, in Kent, and up the river Medway, are places noted for chalk lime. Chalk, carbonate of lime,—56 lime, 44 carbonic acid, when pure. Sand is pulverized rocks of silex, &c. and it is known as *clean* or *round* sand, and *sharp* sand, which consists of grains with flat surfaces, and when enveloped and cemented together by the lime paste, possesses much stronger power of cohesion than the globular, and is taken out of the Thames above Woolwich.

JOINER.

Q. What is joiner's work ?

A. The completion of the wood-work in the several houses, as laying of floors, making doors, window frames, sashes, shutters, &c.

Q. How are floors designated ?

A. According to the quality of timbers used—as rough-inch deal, white or yellow edges, shot (*i. e.* planed fair); inch-wrought folding white or yellow, (*i. e.* several deals are laid within certain breadth and secured by dogs, and are then pressed down by weight, uniting the joints very compactly and closely;) inch deal (white or yellow) straight joint, ( *i. e.* all the joints running in fair lines, the deals being of equal breadth;) inch floor, (white or yellow,) ploughed and tongued headings, edges nailed, (*i. e.* the extremities of the boards, at the hearths, &c. are grooved into a piece running at right angles, making the whole fair;) whole deal dowelled floor, (*i. e.* when the edges of the boards are shot or made fair, small holes are bored into their close sides, and wooden pins or dowels are introduced when the same are united together.) Other floors, for granaries, &c. are ploughed or rebated, and feather-tongued, (*i. e.* when one edge laps over the other about three quarters of an inch, and tongues introduced into each side, similar to dowelling;) straight-jointed batten floors, (from 4 to 7 in.) grooved and tongued. The best floors are sometimes of oak or wainscot.

Q. How are windows made and denominated ?

A. The frame is case-work, to admit of the weights, and divided by *stops* for the sashes to traverse in; the lower part of the frame is of oak—solid; the sashes are made to fit the aperture of various thicknesses, and moulded bars: hence, in measuring such work, it is said, four-inch deal cased frame, oak-sunk sill, two-inch astragal and hollow bars, (or otherwise,) hung double, (or single,) with pulleys, weights, lines, &c.—or, two-inch French casements with circular heads, hung folding, with marginal spaces, &c. (Frame measured separately.)*

Q. How are doors made ?

A. In different pieces. The perpendicular parts are the *hanging stile*, to which the

* The laws of symmetry and strength alike require windows to be exactly one over the other; although our ancestors deviated so strangely. To determine the aggregate area of the windows proper to be made in an apartment, extract the square root of the curvature of such apartment, and the quotient will be the answer. Nor should the apertures be made too high, as the effect of cornice, architrave, &c. is totally destroyed. The number of windows depend on the strength, local position, and elevation of the building.

hinges are affixed—the *closing stile*, to which the locks, &c. are affixed—and the *muntins*, the central pieces. The horizontal pieces are *top rail*, *second rail*, *middle rail*, and *bottom rail:* they are all grooved to secure the *panels* in the intermediate spaces, which are moulded, raised, &c. Doors vary in thickness, from three inches to one, and descend from the most ornamental door down to the common ledged door.*

Q. What are shutters?

A. They differ, like doors, in construction and size. In respectable houses they are fitted in *proper boxings* (*i. e. casings* with *linings*, &c.) and hung with *back flaps*, whilst the *soffits* of the windows, the *backs* and *elbows* (the parts beneath the windows,) correspond in panelling and mouldings. The architraves to the windows finish the internal part of the window, with which those of the doors, recesses, &c. should assimilate. Closet doors, dwarf closets, and doors, should be made the same.

Q. What are door cases?

A. The frames of doors, and are known as *proper door cases*, *double* or *single rebated*, *&c.* one side or both sides.

Q. What are skirtings?

A. The boards in the lower part of rooms or lobbies, staircases, &c. finishing the flooring and the plastering of the wall. They are designated according to their mouldings as *torus*, *double torus*, *reeded*, *&c.* and are either *raking* or *straight*.

Q. What are *surbases?*

A. Mouldings running round the room as a protection to the wall. The intermediate part is termed the *dado*—sometimes panelled, and sometimes plastered.†

Q. What of *staircases?*

A. They are of several forms, arranged according to conveniency, neatness, or grandeur of appearance: these come under the head of *plain* or *straight; dog-legged*, (*i. e.* having, halfway up, a landing called a *quarter space*, or *half space*, if twice the size, from whence the flight is continued the opposite way); *elliptical*, *circular*, (all the stairs being winders), *geometrical*, &c.‡

Q. What are the component parts of a staircase?

A. The *treads*, the flat spaces. (if straight, designated *flyers;* if angular, *winders;*) the *risers*, the perpendicular parts of which support the treads; the *strings*—as wall-string, the string into which the treads and risers are framed; the *carriage*, pieces of quartering running longitudinally under the stairs, to support them; *quarter and half spaces*, *hand-rail newels*, and *balusters*. In superior staircases, of whatever figure, they come under a different denomination, as *risers*, and *treads*, with *rounded* and *moulded nosings*, framed to *wall-string*, with *cut string*, *returned* and *mitred ends*, and *moulded brackets;* mahogany *hand-rail* ramped with *curtail step* and framed *balusters;* carved *newels* with *pendants*, *&c.*

Q. What else come under notice in joinery?

A. Framed closet fronts, with doors for chambers and kitchens, framed spandrils for staircases, plain linings, window-boards, kitchen-dressers with drawers, pot-boards, cut brackets and shelves, fascias, mantel-pieces, shoots, and water-trunks, catilivers and balcony bottoms, verandas, with canopies, trellis-work, &c.

Q. What are the several mouldings used in joinery for skirtings, architraves, and windows?

A. 1, rounded. 2, ovolo. 3, cavettto. 4, quirked bead, or bead and quirk. 5, bead and double quirk, or return bead. 6, double bead, or double bead and quirk. 7, single torus. 8, double torus. 9, cima recta. 10, cima reversa. 11, quirked ogee. 12, quirked ovolo. 13, scotia. 14, single reed. 15, double do. 16, triple do. 17 and 18, reeds round convex surface of a cylinder. 19, astragal and half-round bar. 20, quirked astragal bar. 21 and 22, quirked gothic bars. 23, double ogee bar. 24, quirked astragal and hollow bar. 25, double reeded bar. 26, triple do.

Q. How are doors described?

A. 1, square and flat panel both sides. 2, quirked ovolo, fillet and flat panel, with square back. 3, quirked ovolo, bead and flat panel, with do. 4, quirked ovolo, bead, fillet, and flat panel, with do. 5, quirked ogee, quirk bead, and flat panel, with square

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* In the proportion for small doors generally three feet wide, the height is to the breadth in the ratio of 7 to 3. The height of large doors need not be more than double their breadth. The doors of mansions may be six feet wide; those of public edifices from six to ten feet wide; but these should be folding. Where two doors are thrown into one, by folding doors, the width of the aperture is generally of less height than twice its breadth.

† In genteel houses, the skirting and surbase are superseded by a deep *plinth*, with a rich moulding running on the top of it.

‡ The fixing the situation of a staircase, and deciding the form of the same, affords one of the strongest proofs of an architect's skill. In mansions and palaces, the steps should not be less than four, nor more than six inches high; nor more than eighteen, nor less than twelve inches broad; the width should not be less than six, nor exceed fifteen feet. In ordinary houses, the steps average from six to seven inches high, twelve inches wide, and three feet long. In setting off the staircase, of whatever form, calculate the height from one floor to the other, reduce the same to inches, and divide by the height of the steps, the number of steps will be given. Care must be taken to admit of sufficient height for door-ways, over which they may be thrown.

back. 6, cove, raised bead, and flat panel with square back. 7, quirked ogee, raised bead, and flat panel with square do. 8, quirked ovolo, bead, fillet, and raised panel on front, with square back. 9, quirked ovolo, bead, and raised panel with ovolo on the rising on front of door, with square back. 10, quirked ogee, raised panel, ovolo, and fillet, on rising, and astragal raised on the flat of panel and square back. 11, quirked ovolo, bead and fillet, and flat panel on both sides. 12, bead and but front with square back. 13, bead, flush front, and quirked ogee, raised panel with ovolo on the rising ground on flat of panel on brick. 14, Bilection moulded door.*

STONE-MASON.

Q. What are the different stones used in building?

A. Portland, Bath stone, Yorkshire, and Purbeck; to which may be added, stone found in neighboring districts, as granite, lime stone, and slate; all of which, according to the several purposes, are measured by the foot *cube* (solids above four inches thick); *super* (to all squares and flat surfaces under four inches, as *landings*, &c.); *lineal* (to grooving, throating, Yorkshire and Purbeck steps, and channel stone).

Q. For what purposes is stone used?

A. In some instances throughout buildings, and also for bridges—and columns—in others, for casing fronts of buildings: hence termed *ashlar fronts*—also for paving, plinths, strings, sills, steps, quoins, keystones, copings, parapets, mantel jaumbs, hearths, sinks, &c.†

Q. What are the different kinds of marble?

A. There are several; namely, *statuary*, (the most valuable,) *veined, dove, black and gold, black, speckled, sienna,* and *Elgin.*

Q. For what is marble appropriated?

A. For tombs, monuments, pavements of halls, (being tesselated, giving a pleasing effect,) sometimes columns, grouping, &c. and for mantel-pieces.

Q. How is stone-work secured?

A. It is bedded in mortar or cement, and frequently cramped by small pieces of iron being let in, and bedded in lead.

PLUMBER.

Q. What does plumbers' work embrace?

A. The leading of roofs, gutters, cisterns, pumps, pipes of several sizes, solder, &c. all of which is measured by the square and lineal foot. It also includes fittings to water closets, as stop-cocks, bibbs, stop-bibbs, balls, ball-basses, butts, ferrols, washers and wasters sockets, plugs, &c.

PAINTER.

Q. How is painters' work described?

A. It is done in one, two, three, and four oils, in different colors and shades—imitations of wainscot, oak, satin wood, &c. and then *flatted* by turpentine—all being previously *knotted.*

Q. How is painter's work measured?

A. Wherever the brush goes: all wainscot, dado, doors, window-shutters, jaumbs-linings, mouldings, architraves, &c. are measured by the *yard square.* Chimney pieces, ornamented ceilings, and other enriched, worked, picked in, and small detached pieces, done with variegated or fancy colors, &c. by the *foot square.* Ornamental figures, carved mouldings, cornices, fascias, skirting, water-trunks, &c. by the *foot running.* Sash frames, window-lights, casements, &c. per *piece;* and sash squares by the *dozen.*

GLAZIER.

Q. What is glaziers' work?

A. The glazing of all windows, which is measured by the foot superficial, from rebate to rebate.

Q. What are the different qualities of glass?

A. Plate glass, best Newcastle crown glass, second do., third do, packing and green glass, and ground glass.

BLACKSMITH.

Q. How is blacksmiths' work charged?

A. By the *hundred weight,* namely, 112 pounds, to doors, columns, &c.; by the *pound* to smaller weights; by the *foot lineal* or *super* to railings, balconies, trellises, &c.

NOTE.—Iron-wrought doors, with panels, &c. are directed by Act of Parliament, for dividing large warehouses and stables.

Q. What branches of science are immediately connected with architecture?

A. A knowledge of the classics, the acquisition of geometry, and perspective, and the art of drawing; but above all, to be well skilled in the properties of the materials used—the proper combination of such—and lastly, a due regard to the several conveniences and arrangements of the rooms, according to the purposes of the intended building.

* These mouldings are applicable to shutters, and all panelling. The common ledged, beaded, and braced door is simply boards put together, with transverse and diagonal pieces at the back.

† Walls built with unhewn stone, or without mortar, are called *rubble walls,* which are of two kinds—coursed and uncoursed. In the former the stones are hammer-dressed or axed, each row forming a horizontal face: in the latter they are used nearly as produced from the quarry. The stones which run through the thickness of the wall are called *bond stones.* In *ashlar fronts,* great care is requisite to bind the facing with the rubble or the brick behind.

Safety of Lead Pipes protected by Tin.—Extract of a letter from Mr. G. Chilton, dated New-York, June 23, 1834.

Dear Sir,—Observing, in a late number, a notice of Ewbank's *patent* tinned lead pipes, and having had many applications for information concerning the danger attending the use of metal pipes for conveying water, beer, cider, &c., I have been induced to subject the pipes of Ewbank to a few trials, for the purpose of ascertaining whether, from the occasional contact of acids, any deleterious solution of lead would attend their ordinary use. It is well known, that the common beer pump, with a leaden pipe, has frequently given to the liquor a dangerous impregnation, especially after remaining stagnant for a time, and the beer in a sour state. The substitution of block tin would remove the apprehension of danger, but its greater price offers a strong temptation to the use of lead. It appears to me that the lead tube lined with tin will answer the ends of cheapness, safety, and durability. I would therefore invite your attention to the following experiments, which, if you think them of any importance to the public, you may insert in your Journal.

*Experiments.*—Various portions of lead tube, coated, some with pure tin, and others with different alloys of tin and lead, were bent into the form of a semi-circle, and filled with vinegar of different degrees of strength. After standing, some a month, and others six weeks, with occasional disturbance, the clear solutions were tested, first with sulphate of soda, and afterwards with bi-hydro-sulphuret of ammonia. The application of the first of these tests, namely sal. soda, produced no alteration in any of the solutions, from which it must be inferred that they contained no lead.

The application of the second test produced, as was anticipated, a brown precipitate of sulphuret of tin. In the same manner, two fresh pieces of tube were filled with a strong solution of common salt, which remained in contact for some time. The solutions, when assayed with the same tests, showed that nothing but a little tin was dissolved.

It appears that in all these cases, which I regard as galvanic effects, the tin was the most oxidable metal, although, when not under the influence of polar arrangement and in the open air, lead appears to oxidate sooner than tin. It is scarcely necessary to remind you that results similar to these were obtained thirty years ago by the celebrated Professor Proust, at Madrid, who undertook for the Spanish government an extensive series of experiments on the different alloys of lead and tin, with the express view of determining whether the popular prejudices against the coating of copper vessels with an alloy of tin and lead, which is the common practice, was ill or well founded. Nothing can be more satisfactory than the conclusions he drew from his labors, namely, that as, in all his numerous experiments, neither lead nor copper were dissolved, there is little reason to fear the solution of lead from the tinning of our kitchen utensils. I may just mention here, that I am in the habit of cleaning out my soda fountain every spring with dilute muriatic acid, which uniformly dissolves the oxide of tin without touching the copper, which I am persuaded will remain as securely as the sheathing copper in Sir Humphry Davy's great experiment, and for the same reason.—[American Journal of Science and Arts.]

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Discovery of Silver Ore in the Oural Mountains. — The Oural chain has been for several years well known to Europe for its rich gold and platina ores. A discovery has now been made of rich silver ore in two places. The first is seventy wersts from the foundry of Nischneitagilsk, near to the confluence of the little River Graesnoy with the Tagil, where gold also occurs; the other is twenty-two wersts from the foundry of Nischneitagilsk, on the little River Ulka.

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*On the Location of Railroad Curvatures; being an Investigation of all the Principal Formulas which are required for Field Operations, in laying Curves and Tangent Lines, to pass through Given Points.* By J. S. Van De Graaff. [From the American Railroad Journal.]

Art. 1.—When it becomes necessary for a road to pass from a right line into a curve, the former should in all cases be laid tangent to the latter. It is, however, unnecessary, in ordinary roads, to adhere to this principle with the rigor of an accurate geometrical construction; but with reference to a railroad, it should be observed with the greatest care and precision, *as well as the general selection and distribution of the various curvatures.* This is an obvious consequence of the well known law of *inertia;* for any two points being fixed, in the general direction of a route, through which it is proposed to lay a line of railroad composed of several curves and intervening tangents, the cost of construction is in most cases not the only requisite datum to fix the definite location of the intermediate points.

There are, indeed, very few varieties of ground, except in a very broken country, which will not admit of several different lines, connecting the same points, all at nearly an equal expense of construction, and all within the same *limits* of curvature. It therefore becomes an object to make such a selection of

right lines and curves, and such a distribution thereof, as will produce, *at a given expense*, the most efficient road.

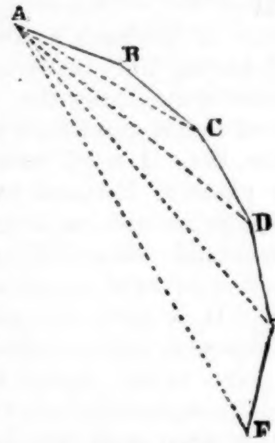
The effect of curvature, upon the *cost of transportation*, does not fall within the present subject; and the only general rules which can, therefore, be here given, as a guide for the arrangement of a line, are the following: Endeavor to open the closer curves by increasing their length, or by increasing the length of some of those which have a greater radius, or by giving some tangent line a different direction. But a sufficient dexterity in the judicious arrangement of the curvatures of a line can only be had from experience; and the principal object which is here proposed is an investigation of the various formulas which are required in facilitating the operations in the field.

2. In order to obtain results which are of commodious application in the field, it is necessary to use only circular arcs for curves; but when the situation of the ground is such as to render a continuous arc of the same curvature inapplicable to the purposes required, a curvilinear line may nevertheless be traced in such a manner as to take any desired form, in order to pass through any number of designated points, by merely connecting together a succession of circular arcs, having different *radii of curvatures*. To make a good selection in the field, for those different circular arcs, requires skill and judgment; but the only additional care to be observed in the operations of tracing such a selected line, will arise from the necessity of connecting the different arcs in such a manner as that they may have a common normal at their point of connection.

The following well-known properties of the circle exhibit the first principles which will be necessary in the subsequent inquiries.

Theo. I. The angle of deflection* between two equal and contiguous chords is measured by the arc which is subtended by either of the chords. II. If there be a tangent line, and a chord from the touching point, the angle of deflection from the tangent line into the chord is one-half of the angle of deflection between two such equal chords. III. Tangent lines from the two extremities of any arc, form equal angles with the connecting chord: each equal to one-half of the intercepted arc. IV. Any angle at the circumference, standing upon a given chord, will have a constant value for all positions of that chord upon the circumference; and this constant value is one-half of the arc subtended by the given chord. These principles are presumed to be familiar to the reader; and have been here transcribed only for the sake of convenient reference.

3. Let any number of equal straight lines, AB, BC, CD, &c., be connected together in such a manner at their extremities, that the angles BAC, CAD, DAE, &c., may be all equal to each other; it then follows from Theo. IV., Art. 2, that the points A, B, C, D, &c., will all be situated in the circumference of a circle. And this obviously suggests the common method of tracing a circular arc in the field, by means of a chain whose length is AB, or BC, or CD, &c., and an instrument for measuring the equal angles BAC, CAD, DAE, &c. It is thus easy to set as many stations in a curve as can be seen from an instrument placed at the station A. The *position* of the first chain, AB, is here taken arbitrarily, and does not effect the *curvature*.



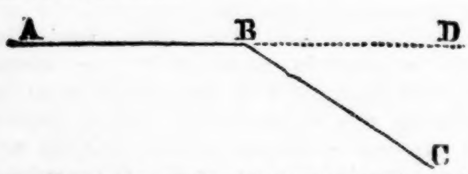

4. In using the formulas which will be deduced in the course of the present inquiry, it must be remembered that all measurements of *distance* are supposed to be made in chains, and the decimal parts of a chain. The chain will therefore be the *unity* of length, and may have any value whatever; but as this will be a constant quantity in the field, it follows, that the *curvature* of a line, traced as in the last article, can only be made variable by assuming, in succession, a different value for those equal angles BAC, CAD, DAE, &c. These equal angles will therefore be called the *modulus* of curvature, and will always be denoted by a letter T. The modulus of curvature will therefore be a constant quantity in the same curve, but variable in different curves; and any curve will be given, when its modulus of curvature is known. The letter $n$ will be taken to denote the number of chains composing any arc which may be under consideration, and the letter D to represent the number of degrees contained in that arc. It is then obvious, from Theo. IV., Art. 2, that each chain will subtend a portion of the circumference equal to 2T; and consequently the following formula is the evident result,

$$D = n \times 2T. \qquad \text{(I.)}$$

This expression gives the number of degrees which any arc contains, when the modulus of curvature and number of chains are known.

5. In tracing a circular arc of given curvature, by means of chords of more or less than one chain in length, the particular modulus of curvature corresponding to any given length of chord will be nearly proportional to the length of that chord, when that length is only a very small part of the whole circumference. For, in this case, the length of the given chord will be nearly proportional to the number of degrees

* The angle of deflection between two lines which meet in a point, is the angle contained between either line and the other line produced.




Thus DBC is the angle of deflection between the two lines AB and BC.

in the arc which it subtends, and therefore, also, by Theo. IV., Art. 2, nearly proportional to its particular modulus of curvature.

Hence T denoting the modulus of curvature for a given curve with a chain whose length is unity, then $p \times T$ will be nearly the modulus of curvature for the *same curve* when traced by means of chords whose length is $p$ chains. This result is only approximative; but a rigorous formula will be investigated hereafter. It is evident, upon the same principles, that (I.) is rigorous only when $n$ is an *integer* number of chains.

6. Since each chain in a curve subtends a portion of the circumference equal to double the modulus of curvature, it follows, from Theo. I., Art. 2, that the angle of deflection between any two contiguous chains will likewise be equal to double the modulus of curvature. And it thus also obviously appears, from Theo. II., Art. 2, that the angle of deflection from any chain, into a tangent line at either of its extremities, will be equal to the modulus of curvature.

7. When a given curve contains more than one chain of the same modulus of curvature, and the direction of a tangent line at any station be required, it should never be found from the direction of the first chain at that station; for small errors will arise, both in placing the instrument vertically over one of the stations, and in taking the back sight to the centre of the other, and the angular effect of these errors will obviously diminish as the two stations are more remote. In order, therefore, to obtain the direction of a tangent line at any station in a given curve, direct the instrument into a chord, embracing a number of chains in the proposed curve, denoted by $n$; and it then appears, from Theo. III., Art. 2, that $\frac{1}{2}$D will express the angle of deflection from the selected chord into the required tangent line. Hence, by Art. 4, the formula required in obtaining the direction of a tangent line is,

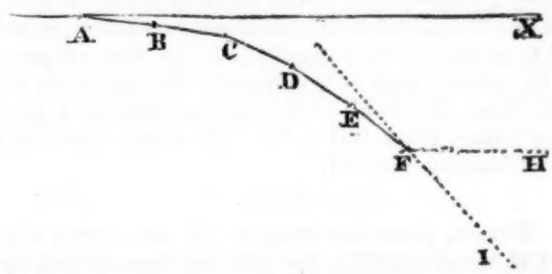
$$\tfrac{1}{2}D = n \times T. \qquad \text{(II.)}$$

8. The general method of tracing a curve in the field, having the modulus of curvature given, will appear from Art. 3; but it remains yet to show how such a curve may be laid to a given tangent line at a given point. It is obvious from Art. 6, that the required object will be attained by laying the first chain from the given point with an angle of deflection from the given tangent line equal to the modulus of curvature of the proposed curve. For then the same curve may obviously be continued from that first chain to any number of chains, by the method of Art 3.

9. It is frequently necessary to pass from one given curve into another, having a different modulus of curvature. When this case occurs, the instrument must be placed at the station where the change of curvature is to be made; and let it be directed into the *tangent line of the first given curve* at that station, agreeably to the method in Art. 7. The instrument may then be considered as adjusted, so as to be in readiness, either to lay a *continuation* of the first given curve, or to lay any other curve, from another given modulus of curvature, in such a manner as to have a common tangent with the first curve at the *point* where the two curves pass into each other; and it is sufficiently obvious that, in either of these two cases, the selected curve must be traced agreeably to the principles given in Art. 8.

When, therefore, a change of curvature occurs at any station, the angle of deflection between the two chains at that station will be equal to the *sum of the two moduli of curvatures.*

10. Let AB, BC, CD, &c. represent the successive chains by which a given curve, ABCD, &c., may be traced from its origin at the station A, in such a manner as to touch a given right line, AX, at that point. It is proposed to investigate a formula which will express the inclination of the given tangent line AX, to the $n$th chain in the given curve, estimating from the origin at the point A.




Take EF to represent the $n$th chain; and let the letter E denote the required inclination of the line EF to the given tangent line AX. The inclination of the first chain, AB, is expressed by the given modulus of curvature T, agreeably to Art. 6, or 8; and consequently, the inclination of the second chain, BC, will be expressed by T + 2T, or 3T. In like manner the inclination of the third chain, CD, is expressed by 3T + 2T, or 5T. Hence the inclinations of all the chains AB, BC, CD, &c. will obviously be expressed by T, 3T, 5T, &c. respectively. The problem is therefore evidently reduced to the following very simple inquiry, viz.: To find the value of the $n$th term of the series 1, 3, 5, 7, &c. But agreeably to the principles of arithmetic, this $n$th term will be expressed by $2n-1$. The desired formula will therefore be,

$$E = T \times \overline{2n-1}. \qquad \text{(III.)}$$

The expression (III.) will be frequently very convenient in the field when it is required to compute the magnetic bearing of any particular chain in a long curve, when the bearing of the given tangent line at the origin is known. If the country be free from metallic matter, and the instrument be in proper order for use, the magnetic bearing will always serve as a very useful check in detecting any material error which may have been inadvertently committed in the previous deflections. By way of a numerical illustration of this, let the given tangent line AX bear due North; and let the given modulus of curvature be 2°, to find the bearing of the 20th chain. Here $T = 2°$, $n = 20$; and therefore $E = 2° \times \overline{40-1} = 78°$; and if the

curve be supposed to bend to the left, then the bearing of the 20th chain is N. 78° W. If the observed course do not correspond with this result, some error has been committed in tracing the curve. This method of proof is so very simple, that it should be attended to frequently in tracing long curves, in order to avoid useless labor after some error may have been already committed. The magnetic bearing of a particular chain in a curve is also sometimes required in the field for other purposes.

11. Let ABCD, &c., represent a given curve traced as in the last article; and take EF to represent the $n$th chain estimated from the origin at the point A. It is proposed to find a method of directing the instrument, when placed at the station F, into a position parallel to the given tangent line AX at the origin of the curve.

Direct the instrument into a chord, through any of the back stations, as for instance the station C or D, (see fig. Art. 10,); and, from that chord, deflect into the tangent FI, at the station F, agreeably to the method given in Art. 7. Take D′ to denote the inclination of the tangent FI, to the given tangent AX at the origin of the curve, and it evidently follows, from Art. 6, that, $D' = E + T$; or, substituting for E its value from (III.), the following expression is at once obtained,

$$D' = 2nT \quad . \qquad \text{(IV.)}$$

Hence, from the tangent FI, deflect an angle IFH equal to $2nT$; and the instrument will then have the required position FH.

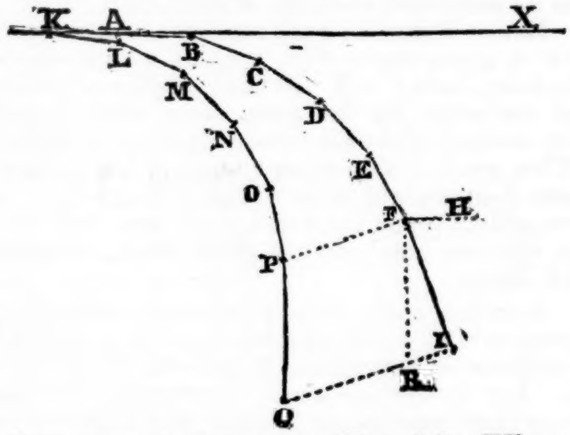
The principle which has just been explained will very frequently be highly useful in the field. For if the origin of the given curve ABCD, &c. be removed from the point A, to any other point in the tangent line AX, then the station F will be changed exactly by the same quantity, and in the same direction, upon the line FH, as will be hereafter shown.

12. Let any two curves be laid upon the same tangent line, and take T and T′ to represent the two moduli of curvatures, and let each curve pass into a tangent at the extremities of the $n$th and $m$th chain respectively. It is then proposed to determine a formula which will express the inclination of those latter tangents to each other.

Take $z$ to denote the inclination required. From (IV.) it appears, that $2nT$, and $2mT'$, respectively, will express the inclination of each of the proposed tangents to the common tangent at the origins of the two curves; and hence the difference between the quantities $2nT$ and $2mT'$ will obviously express the value of $z$. The formula required is therefore the following,

$$z = 2nT - 2mT'. \qquad \text{(V.)}$$

The expression (V.) will find an application in the field in all cases where two tangents are under consideration; for in computing the rate at which any two tangents converge or diverge, their inclination to each other is, of course, the first datum required. The principles contained in (V.) and its application to different cases occurring in the field, will be more easily explained by a reference to a figure. Let A B C D, &c., represent the curve whose modulus




of curvature is denoted by T, and let EF represent the $n$th chain, and FI the tangent at F. In like manner let KLMN, &c., represent the curve whose modulus of curvature is denoted by T′, and let OP represent the $m$th chain, and PQ the tangent at P.

Draw FH parallel to KX, the common tangent at the origins of both curves; and draw, also, FR parallel to the tangent PQ. The inclination of the tangent FI, to the common tangent KX, will evidently be expressed by the angle HFI, or $2nT$; and the inclination of the tangent PQ, to the same common tangent, will in like manner be expressed by the angle HF R, or $2mT'$. Hence the angle IFR, which measures the inclination of the two tangents, FI and PQ, *to each other*, will be expressed by the quantity $2mT'$—$2nT$. When, therefore, the value of $z$ in (V.) comes out *negative*, it shows that the line FR falls below the tangent FI; that is, *the two tangents in that case diverge.* When $z$ comes out positive, the line FR will be situated above the tangent FI; that is, in such a case the two tangents PQ and FI *will converge.* It is here supposed, however, that the two curves do not intersect each other.

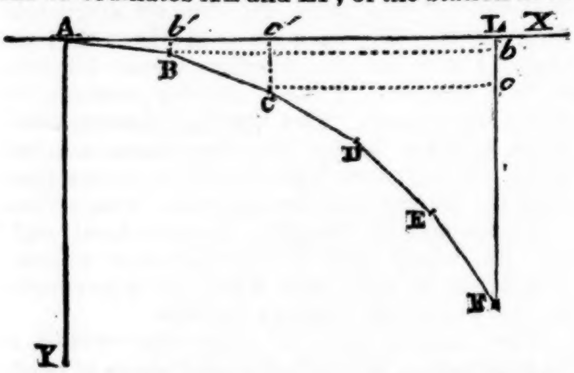
It is sufficiently obvious that the angle $2nT$ will remain the same, whatever position may be given to the origin A in the tangent line AX; and it hence evidently follows, that the distance AK, between the two origins, has no connection whatever with the inclination of the two tangents, FI and PQ, to each other. The distance AK will, however, have an effect upon the line PF, which expresses the distance between the extremities of the two curves. Supposing the distance AK, and the moduli of curvatures, with the number of chains, $n$ and $m$, contained in each curve, to be all given, the line PF may be computed by methods which will be hereafter explained; and then the angle IFR, which measures the inclination of the two tangents, FI and PQ, to each other, being known from (V.), it will be easy to compute the situations of any proposed points, in those two tangents, which may come under consideration in the field, by the common methods of plane trigonometry.

When the distance PF is very small in comparison with the length of the tangents FI or PQ, and when these tangents are but little in-

clined to each other, every necessary calculation in the field may be made by means of very simple approximative methods. All this will be fully explained in the subsequent articles.

13. Let AB, BC, CD, &c. represent the successive chains by which a given curve ABCD, &c., may be traced from its origin at the station A, in such a manner as to touch a given right line, AX, at that station; and let EF represent the $n$th chain, counted from the origin at A.

Taking AX, and AY, for a system of rectangular co-ordinate axes, it is proposed to investigate formulas which will express the values of the co-ordinates AL and LF, of the station at F.




Put $x =$ AL, and $y =$ LF. The inclination of the first chain AB, to the axis of $x$, is found by Art. 10 to be $=$ T; and therefore the projections of AB upon the co-ordinate axes will be, A$b'$ $=$ AB $\cdot$ Cos. T, and L$b$ $=$ AB$\cdot$ Sin. T. But as all lines are supposed to be measured in chains, it follows that the projections of AB upon the co-ordinate axes are, A$b'$ $=$ Cos. T, and L$b$ $=$ Sin. T. Again, by Art. 10, the inclination of the second chain BC to the axis of $x$ is $=$ 3T, and consequently the projections of BC upon the co-ordinate axes, are $b'c' =$ Cos. 3T, and $bc =$ Sin. 3T.

In like manner let each of the other chains be projected upon the co-ordinate axes; and then taking the sums of those projections, the following equations will obviously be the result,

$$x = \text{Cos. T} + \text{Cos. 3T} + \text{Cos. 5T} + \ldots\ldots \text{Cos.}\left\{\text{T}\cdot\overline{2n-1}\right\}\cdot$$

$$y = \text{Sin. T} + \text{Sin. 3T} + \text{Sin. 5T} + \ldots\ldots \text{Sin.}\left\{\text{T}\cdot\overline{2n-1}\right\}.$$

The reason for writing the last term, in each of these two series, as the $n$th term, requires no explanation; and the *sum* of $n$ terms of each series being taken agreeably to the known principles of analytical trigonometry, the following formulas will be the result,

$$x = \frac{\text{Sin. } 2n\text{T}}{2\ \text{Sin. T}}$$

$$y = \frac{\text{Sin. }^2 n\text{T}}{\text{Sin. T}}. \qquad \text{(VI.)}$$

The form in which the expressions (VI.) appear is that most convenient for logarithmic computations; and it is also a form which will be required hereafter for other purposes. But for use in the field, with a table of natural sines and cosines, the expression for the value of $y$ may have a better form. Thus, agreeably to the principles of analytical trigonometry, 2 Sin. ${}^2n$T $=$ 1 — Cos. $2n$T; and consequently the expressions (VI.) become,

$$x = \frac{\text{Sin. } 2n\text{T}}{2\ \text{Sin T}}$$

$$y = \frac{1 - \text{Cos. } 2n\text{T}}{2\ \text{Sin T}}. \qquad \text{(VII.)}$$

Such are the formulas which it was proposed to investigate. For an example in figures, let the modulus of curvature be 1°, and suppose it were required to find the values of AL and LF, corresponding with the extremity of the 40th chain. In this case, then, $2n\text{T}=80°$; and by the table of natural sines and cosines, at the end of this volume, I find Sin. 80°$=$.98481, Cos. 80° $=$ .17365, and Sin. 1° $=$ .01745; hence,

$$x = \frac{.98481}{.03490} = 28.214 \text{ chains; and}$$

$$y = \frac{1 - .17365}{.03490} = \frac{.82635}{.0349} = 23.675 \text{ chains.}$$

If, therefore, the chain used in tracing the curve be 100 feet in length, then AL $=$ 2821 feet, and LF $=$ 2367 feet.

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## *Packet Waggons.*

To the Editor, &c.

For the conveyance of packets, or small packages, from one part of our country to another, the following system may be adopted. A store is selected in New-York city as a receiving, forwarding, and distributing office. A package is deposited there, directed to some town in the United States, as Haverhill, Mass. From New-York it is then carried with other packets to Boston, to a receiving office there. Here packets are distributed to different parts of the country; and the packet to Haverhill is carried to an office there. If it is a regular periodical publication, the person to whom it is sent knows when to call for it; or, if he has directed a parcel to be transmitted to him, he expects it of course; but, if it is sent to him by a friend, a letter by mail announces the coming package.

Respecting the expediency of establishing such a system of packet waggons, the following remarks may be made.

There is now a great amount of transportation over the country. I have seen it stated that one mail has carried from New-York 3,000 pounds of letters and packets. It has been remarked of the mails from Boston that they are excessively loaded. But the stages do not convey all the periodicals that circulate over the country; for many go by water, and many are distributed by private opportunities. Add together all the literature that is dispersed over the country, critical, scientific, fictitious, classical, and religious—weekly, monthly, quarterly, annual, and occasional—and you have a vast amount of paper to be conveyed.

But it may be further observed that the amount of transportation increases. The lite-

rature of the present day is of a more periodical character than it has been, and periodical publications are many of them of more solid worth than formerly. Books are made cheaper, and they are printed in greater abundance, and the reading population is vastly increased, and there is therefore a much increased transportation of printed paper. The transportation increases also by the influence of great printing establishments. By having a wide circulation for their books, they can print them in great numbers, and by superior presses, and with steam power; and thus they can afford them cheap, and very distant readers are advantageously supplied.

Another fact may be attended to. Transportation by waggons may be much cheaper than by mail stages. It costs four times as much to transport a load at the rate of eight miles an hour, as to transport it at the rate of two miles an hour. Packages might easily be carried 33 miles a day at one-third the expense now attending the conveyance by mail coaches; and for most purposes this would be sufficiently rapid. From New-York, by steam and wind, packages might be carried cheaply and expeditiously to the North and South, to Bangor, Portland, Boston, and New-Haven—to Norfolk, Charleston, and Savannah. From some of these larger depots, lines of conveyance may be established to places of inferior importance, so that every family might find within ten miles, and most families within two or three miles, a place of deposit, where parcels might reach them from distant sections of the Union.

It may again be noticed that the course of trade now requires more transportation. Business is conducted by larger establishments, and the public is benefitted by it. Said Mr. S., a close, calculating farmer, "You may now buy a handsome, iron-hooped, painted pail cheaper than neighbor A. sells one of his clumsy ones." Though neighbor A. loses his business of making pails, the town is on the whole greatly benefitted, and he can turn his hand to some other profitable business; and we can send 100 miles and get our pails cheaper than a cooper at our next door can afford to sell them. This is a specimen of the advantages arising from good means of communication. It was stated not long since in England, that fine goods, parcels of value, and all light articles, which needed to be conveyed with speed and certainty, were sent at great expense by coaches. In many cases light and small articles would be sent by a regular line of conveyance, though more expensive than by the present ordinary routes of trade. The means of communication that now exist have scattered friends and relatives widely from each other, and a regular system of transportation would accommodate them, and be improved by them.

The system recommended now exists to some extent. From one seaport to another bundles are carried by packets, and distributed according to the direction on them; and in some cities, baggage waggons carry goods into the interior towns. This system thus commenced may be made more complete. A deposit store is selected in New-York for Boston or Portland. A packet or steamboat takes the packages left in them, and sends them on in the line with which it is connected, to Boston, Portland, or Bangor, according to their direction. In Boston, if directed to a town near there, they are placed in the deposit store, and the packet waggon that passes to or through that town forwards them; and here they reach their destination; and from the deposit store here they are taken by the person to whom they are sent. I live in the country, about 30 miles from a seaport. I have articles sent me 100 miles by water. The packet master takes these articles to the seaport nearest me, and there the merchant with whom he stores them pays the freight, and the one who brings them up to me pays the freight to the merchant, and I pay the whole cost of transportation to him; both what he paid and what he is to receive for conveying the articles by land.

The establishment of a general system of transportation will help the publishers of books and periodicals, and it will help families.

It will help families. If they wish for a book from their nearest market town, there is a regular line to convey it. If they wish for a book or periodical from a distant city, they can obtain it. They write to the bookseller: he places it in the deposit store, and it is forwarded. Thus families in remote towns have easy access to the literature of the day. If a benevolent society wish to procure a quantity of tracts, or Sabbath school books, they have only to send to a remote establishment, and a bundle is placed in the deposit store, and it goes on to their direction like a letter in the mail.

Such a system of transportation again will help publishers. Postage is one impediment to the circulation of periodicals. It often amounts to one quarter, to one half, or even three quarters the original cost of the periodical. This operates like a heavy duty. Remove this duty, and the circulation of periodicals will be greatly increased, and books in general will be purchased more freely, and printers and booksellers will find increased encouragement.

But to establish such a system a clause in the post office law must be repealed, which enacts "that no person, other than the post-master-general, or his authorized agents, shall set up any foot or horse post, for the conveyance of letters and packets upon any post road which is or may be established as such by law." But if it is seen that the public interest requires the repeal of this clause, Congress can repeal it; and printers, publishers, booksellers, and buyers, can petition for this object.

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